Utilization of Simulators in Veterinary Training

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ABSTRACT

Delivering training for practical and clinical skills is becoming increasingly challenging for both the veterinary and medical professions. Simulators provide a potential solution to some of the training issues and are extensively used in medical clinical skills laboratories. The simulators available range from relatively simple physical models to highly sophisticated computer-enhanced training environments. Veterinary schools are also developing skills laboratories, which are equipped with some of the more generic medical models as well as an increasing number developed specifically for the veterinary market. There are a range of physical models, whole animal or body-part, and a small number of computer-enhanced simulations that include haptic (touch) feedback for teaching certain palpation-based examinations.

KEYWORDS

Simulator, clinical skills, virtual reality, haptic, veterinary education

INTRODUCTION

Veterinary education is facing a number of challenges, none more so than in the area of clinical skills training. There have been several changes that have affected clinical training in recent years. Student numbers have risen, which places extra pressure on both intramural clinical rotations and extramural studies (EMS) as learning opportunities. Veterinary schools have an increasing role providing specialist referral services to the profession, and consequently the proportion of first opinion cases that students encounter at university is decreasing. Therefore, ensuring that students acquire the basic practical, clinical and surgical skills and a working knowledge of common cases is becoming more difficult.

In veterinary and human medicine, clinical training has relied for many years on an apprenticeship type model, described by Halsted (1904), where the trainee shadows a more experienced clinician, initially watching the expert and then performing the procedure under the expert's supervision. This approach still plays an important part in veterinary and medical training but, as students have fewer opportunities to practise and clinicians are busier, there is a need to develop new approaches to complement the traditional methods. There are also ethical issues to consider and with increasing public awareness there is resistance to trainees practising on real patients, human or animal (Martinsen and Jukes 2005). There are moves to find alternatives where appropriate and to try to equip trainees with at least the basic skills prior to examining real patients.

One way of supplementing traditional training is for students to learn practical skills and surgical procedures using simulators. The trainee gains hands-on experience in a standardised and safe environment without risk to the patient. Modern medical schools have well equipped clinical skills laboratories where students are trained and assessed using simulators. Veterinary schools are also beginning to develop and use skills laboratories. These are equipped with a range of models, some of which were originally developed for medical training, where skills are common to both professions, as well as an increasing number of veterinary specific models (Hart *et al* 2005; Scalese and Issenberg 2005). These facilities are a particularly useful way to prepare students for clinical training in first opinion practice, where a knowledge and mastery of the basic skills is fundamental if students are to make the most of these learning opportunities.

This paper will describe some of the range of simulators that are now available for use in clinical training. The field of simulation is more advanced in human medical training and will be described first, followed by simulators adapted and developed for veterinary training needs. Finally, simulators that use haptic (touch) feedback technology will be described. These are of particular relevance when trying to address the challenges of teaching certain internal examinations, including bovine or equine rectal palpation.

SIMULATORS FOR HUMAN CLINICAL SKILLS TRAINING

Simulators have been used in medical training for many years. An early example, a life-sized obstetric mannequin and baby with flexible limbs used to simulate a range of presentations, was developed by a French midwife in the eighteenth century (Gelbart 1998). There are now a large number of simulators available from relatively simple bench-top models, such as suturing pads and body-part models, to sophisticated mannequins and hi-fidelity computerised training environments (Maran and Glavin 2003). At the basic level, trainees can practise performing minor procedures including wound closure, catheter insertion and intubation, while the advanced simulations provide an environment in which teams can learn to deal with challenging situations such as anaesthetic emergencies (Gaba *et al* 2001). An example of a relatively simple mannequin is the dummy used for 'First Aid' training that allows members of the public to practise simple life saving procedures. A more sophisticated example is the cardiac simulator 'Harvey', a computer-enhanced mannequin (University of Miami). Trainees can examine a normal patient or one simulated to exhibit symptoms of cardiac disease. The model has a pulse, exhibits respiratory movements and can be auscultated for heart sounds, all of which change to represent different disease conditions. Some mannequins provide additional feedback including responses to the trainee's actions, such as drug administration and minor procedures, and performance evaluation. An example is 'Stan' – Stan D. Ardman - The Human Patient Simulator™ (Medical Education Technologies, Inc.).

In addition to physical models (whole or body-part), there are an increasing number of virtual reality (VR) simulators (Liu *et al* 2003). The trainee performs procedures while interacting with computer generated representations of the patient or relevant anatomical structures. One example is CathSim (Immersion Corporation), which is used for practising intravenous catheter placement. The trainee can select from several patient options including normal adults or the more challenging veins of geriatric and paediatric patients. Virtual reality simulators have proved particularly applicable for training in minimally invasive surgery (MIS), where the surgeon operates through a small incision, a 'keyhole', and views the instrument actions on a monitor. In the virtual environment, the surgeon practises with modified instruments while viewing a graphic representation of the operating area in real time. A number of VR simulators have been developed for laparoscopic procedures e.g. cholecystectomy, and endoscopic procedures e.g. bronchoscopy and colonoscopy (Immersion Corporation).

The wide range of simulators available, and their inclusion in the skills laboratories at many medical schools, is indicative of their importance in modern medical training. New initiatives will continue to harness technological advances as well as finding novel ways of using existing simulators. For example, body-part simulators have been combined with simulated patients (actors trained to play the part of patients) to try to produce a more realistic learning experience (Kneebone *et al* 2006).

SIMULATORS FOR VETERINARY CLINICAL SKILLS TRAINING

Many skills are common to veterinary and human medical training. Therefore, some medical models are also suitable for use in veterinary clinical skills laboratories. Such models can be used for students to practise e.g. intravenous catheter placement and blood sampling (BristolMedicalPro) as well as basic surgical techniques including suturing, instrument handling, knot tying and blood vessel ligation (Smeak *et al.* 1991; Olsen *et al.* 1996). A human mannequin (The Human Patient Simulator™, Medical Education Technologies, Inc.) has been used to teach induction and maintenance of anaesthesia to veterinary students (Modell *et al.* 2002). Another approach is to use species specific models. A range of canine and feline mannequins have been developed by Rescue Critters for teaching intravenous access, bandaging, auscultation and endotracheal intubation. Another canine mannequin has a skeleton and articulating joints (Rhosyn Designs) and is used for bandaging and positioning for radiography. Models of a canine forelimb and the head and neck are available from UC Davis for practising vascular access, blood sampling and intubation.

A number of surgical models have been developed specifically for veterinary training. These include the Dog Abdominal Surrogate for Instructional Exercises (DASIE), made from laminated fabric and foam rubber, which students can use to practise handling surgical instruments, suturing and placing ligatures (Holmberg *et al.* 1993). A hollow organ simulator, made from laminated polyurethane, is used for performing gastrotomies and hollow organ closure (Smeak *et al.* 1994). Other surgery simulators include one developed for canine ovariohysterectomy (Griffon *et al.* 2000) and another for practising various surgical procedures on the spleen, liver and kidney (Greenfield *et al* 1993). There are also canine plastic bones, which have been used for teaching orthopaedic surgery for many years (Deyoung and Richardson 1987).

For large animal teaching, life-sized models are used in animal husbandry classes. A model horse is used for bandaging, rugging and tacking up. A model cow is used for students to learn how to put on a halter or apply a rope for casting, and the model can be modified for drawing milk samples. An equine colic model has been developed with a fibreglass rear-half of a horse containing plasticized preserved intestines and plastic models of other organs (Von Künzel and Dier 1993). The model allows students to perform a rectal examination while the instructor positions the intestines to represent the normal anatomy or one of a number of colic scenarios.

These simulators represent some of the increasing number available for veterinary training. As well as having an important role in the teaching of practical skills, simulators are used for assessment in certain OSCE (Objective Structured Clinical Examinations) stations (Bark and Cohen 2002). New models continue to be developed and existing ones extended or modified to address the challenging range of skills required of the veterinary graduate.

HAPTIC SIMULATORS

A relatively new area of simulator development involves computer technology that provides haptic (touch) feedback as well as graphic representations. In a simulation enhanced with haptic technology, the trainee interacts with a computer-generated virtual environment and can feel the softness or firmness of an object and appreciate subtle variations in the shape and size. In medical training, haptic technology has been used to augment simulators used for minor procedures such as epidural injections

(Dang *et al* 2001) and suturing (Webster *et al* 2001). Haptic simulators have also been developed for palpation-based procedures, where touch is the primary and sometimes only sense available to the clinician. These simulators include ones developed for teaching trainees to perform digital rectal examinations (DRE) to detect prostate cancer (Burdea *et al* 1997; Kuroda *et al* 2005), and another for training osteopathic students: the Virtual Haptic Back (Williams *et al* 2004).

A haptic simulator of particular relevance to farm animal practice is the Haptic Cow, which has been developed for teaching bovine rectal palpation. The Haptic Cow uses a PHANTOM haptic device (SensAble Technologies) and virtual models have been created to represent the reproductive tract (cervix, uterus and ovaries), which can be positioned within the pelvis or caudal abdomen. The simulator training is designed to support the progressive acquisition of skills from learning to find and identify key structures (the pelvic landmarks, cervix, and uterus) to performing pregnancy diagnosis. As the student palpates the virtual models, the instructor can follow the hand movements on the computer monitor and therefore guide the examination.

During the development of the Haptic Cow, steps were undertaken to evaluate the simulator as a teaching tool. The design or feel of the virtual models was assessed by veterinary surgeons (Baillie *et al* 2003) and improved on the basis of their feedback. The training effects of the simulator were assessed by comparing the performance of two groups of novice veterinary students: one group trained with the simulator, the other group received only traditional training (Baillie *et al* 2005a). The students were set the task of finding the uterus when subsequently examining cows and the simulator trained group were significantly better at the task. A further study looked at the feasibility, benefits and challenges of integrating the simulator into a curriculum at the University of Glasgow (Baillie *et al* 2005b).

The Haptic Cow is now in use at several veterinary schools and has found a number of applications in farm animal training. For example, in preparation for the first bovine rectal palpation, students can be taught the skills required to find the uterus. This is fundamental skill and, until mastered, students cannot progress to performing fertility examinations, pregnancy diagnosis or even putting a scanner in the right place. The simulator can also be used to run a simulated fertility visit. The instructor has the role of the 'farmer' and the students take it in turns to be the 'vet' and examine a series of fertility cases. The students have to bring together a range of skills including palpation, diagnostics and therapeutics, and communicate in a way that the 'farmer' understands.

Another haptic simulator has been developed for teaching rectal palpation of equine colic cases. This version includes virtual models of the structures palpated in the normal abdomen as well as examples of horses with colic: pelvic flexure impactions, dilated loops of small intestine and displacements of the colon. Training with the simulator has been found to have beneficial effects (Rendle and Baillie 2007). However, it is important to emphasise the differences between the simulator and a real horse, and to provide guidance on safe practice for equine rectal palpation. Another equine model has been developed by Crossan (2004): a Horse Ovary Palpation Simulator (HOPS). In the model, the number, size and position of follicles on the virtual ovaries can be altered, simulating different stages of the mare's reproductive cycle.

Ongoing research and development aims to extend the range to other procedures and species including models for teaching palpation of the canine prostate and feline abdomen. Additionally, haptic technology can be used to investigate aspects of performance for palpation-based skills and could provide information about an expert's or novice's technique, which would be useful when designing future teaching tools.

DISCUSSION

There are increasing difficulties associated with providing adequate opportunities for veterinary students to learn clinical skills. In human medicine, clinical skills laboratories are used to provide training for many practical and surgical skills. These laboratories are equipped with simulators that range from simple models to mannequins and sophisticated computer-enhanced simulated training environments. The veterinary profession are now developing their own skills laboratories and are adapting simulators used in medical training as well as designing an increasing number of veterinary specific models.

Simulators offer a number of advantages over conventional teaching methods. The environment is safe for the patient and also for the student, which is particularly relevant to certain areas of veterinary training. Some of the more interactive simulations register trainee's actions and mistakes. This provides an even richer learning experience but without the potentially serious consequences to the patient. However, it is important that the trainee is also aware of the differences between learning on the simulator and performing the task on the real patient or animal. Additionally, simulators represent a readily accessible resource that can be used to provide training in a standardised and controlled way. Students can practise a skill repeatedly until mastered as well as using simulators strategically to address skill deficiencies or complement clinical cases.

However, to ensure the maximum benefits for trainees there are certain issues to consider. The wide range of skills veterinary graduates need to master represents a challenge that requires a resourceful and ingenious approach to the development of new models and simulators, or the modification of existing ones. Crucial to the development of simulator-based training tools is a thorough knowledge of the ways in which experts perform tasks, and an understanding of the trainees' learning needs and difficulties. This means that, as well as taking the opportunity to harness the advances in technology, adhering to sound design and educational principles is important. Additionally, whatever the simulator or model, the developers have a responsibility to ensure that the design supports the performance of the required tasks and that trainees are equipped with useful transferable skills. Without due consideration for these factors, the benefits to trainees and ultimately patients, human or animal, cannot be guaranteed.

CONCLUSIONS

Simulators have great potential to address some of the difficulties faced when trying to deliver clinical skills training in a modern veterinary curriculum. Students have access to a safe, flexible and accessible learning environment where they can practise repeatedly in a standardised setting. If used appropriately, simulators are a valuable complement to traditional training methods and enable students to make more effective and efficient use of clinical cases as learning opportunities. Simulators are likely to play an increasingly important role in the training of the veterinary graduates of the future.

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